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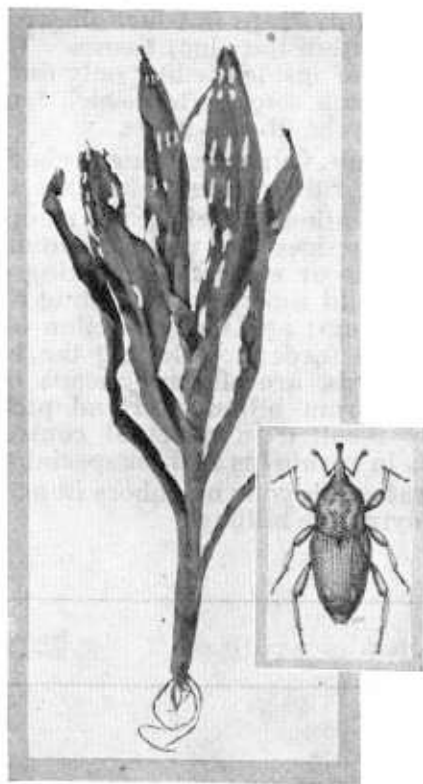
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1003 *Per*

5/32

HOW TO CONTROL BILLBUGS

DESTRUCTIVE TO CEREAL
AND FORAGE CROPS



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BILLBUGS DESTROY OR INJURE corn, wheat, rye, barley, oats, timothy, bluegrass, Bermuda grass, Johnson grass, rice, sugarcane, peanuts, and chufa. The most conspicuous damage by the adult billbugs is done to young corn plants. The most costly damage is undoubtedly that done by the larvae or grubs in cutting the underground portions of plants, especially those grown for hay and pasture.

Billbugs have only one generation yearly and are generally dependent on grass sods or wild sedges and rushes. Corn, sugarcane, chufa, and timothy probably are the only crops in which they can perpetuate themselves within the plant tissues. The other host plants admit of inside feeding only during the early part of the grub stage, after which feeding is completed among the fibrous roots.

Parasites are valuable natural checks, but their work follows, rather than prevents, crop loss.

Clean cultivation, especially the complete elimination of wild sedges and rushes; suitable crop rotations; summer or early fall breaking of cultivated or infested wild sods; early planting of crops menaced by billbugs; and the protection of birds, especially ground feeders, including the bobwhite and the shore birds, are efficient means of preventing crop losses from billbugs. Hand picking has occasionally resulted in effectual control of billbug outbreaks in cornfields and on special turf.

Cooperate with your neighbors in active measures for destroying the billbugs.

HOW TO CONTROL BILLBUGS DESTRUCTIVE TO CEREAL AND FORAGE CROPS

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NATURE AND EXTENT OF INJURY

PREVENTING BILLBUGS from destroying corn, wheat, and other cereals and forage plants is vitally important to many farmers throughout the country. The first evidence of the presence of the billbugs in cornfields usually is the appearance of rows of holes in the corn leaves. These holes are made by the beetle before the leaf unrolls.

The principal injuries to corn occur in the spring when the beetle reduces the stand or shortens the season for replanted corn, or does both. A still greater loss may result if the farmer, discovering the damage, abandons the ground for the season, thus losing the opportunity to crop the land and sometimes allowing the natural food plants of the billbugs to take possession for years to come.

Injuries to cultivated grasses and to small grains probably are much greater than injuries to corn, although the former are unnoticed except in extreme cases.

The havoc wrought by the large billbugs that usually infest swamp grasses shows the need of caution in planting corn near marshes, especially on recently drained land, where bulrushes, sedges, and other coarse, wild grasses have grown. This ground can be brought into corn production without loss, by preceding the corn planting by one year's planting of crops distasteful to the billbugs.

The adult billbugs usually feed on the same kind of plant that has furnished food for the larvae, and they ordinarily do not travel much. If their desired plants are destroyed, however, they will

migrate as far as necessary to reach others of the same kind, and may destroy much corn as they go.

Over a large area in Illinois showing serious infestation it was found that billbugs injured from 50 to 75 per cent of the timothy corms in old fields, whereas in the younger, 2-year-old timothy sods only 10 to 20 per cent of the corms were injured. Of infested corn hills, 33 per cent failed to produce ears, some fields yielding only 20 to 45 bushels per acre where the normal yield was 80 bushels.

The larger billbugs may be sufficiently abundant in reclaimed swamp land to destroy two or three complete replantings of corn.

The smaller kinds in timothy sod plowed under for corn rarely destroy more than about 50 per cent of the first replanting and do little subsequent injury, although sometimes even a second replanting may be almost destroyed.

The losses in corn usually are caused by the adults, except in the case of the maize billbug and the curlew bug, where both adults and grubs cause injuries. Each transverse row of holes in a corn leaf (fig. 1) results from a single puncture made by a beetle through the layers of a rolled-up leaf. The corn plants may be deformed in two ways: (1) The perforated leaf, by falling or twisting, may interfere with the growth of the following leaves (fig. 2); and (2) injury low down on the stalk may cause sprouting or suckering (fig. 3). Loss through the first type of injury may be reduced by promptly clipping off the deformed leaf, but injury of the latter type is irreparable.

Although injury to corn usu-

ally takes place early, damage may appear after the corn is 4 feet high.

Injury to bluegrass done by adult billbugs appears in the stem between the roots and the second joint, in the form of numerous punctures, ragged as if the fibers were torn apart, but often there is no evidence that the beetle has fed on the soft central tissue, or even disturbed this tissue.

Other losses are caused by extensive feeding of the young or grubs on the fibrous roots of grasses and grains, within timothy corms, and to some extent within the stems of small grains. (Figs. 4 and 25.) Injury done by the grubs to small grains occasionally

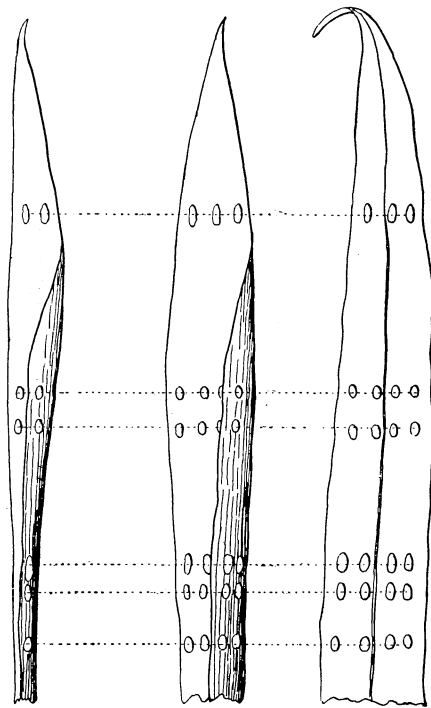


FIGURE 1.—Diagrammatic figures showing rolled corn leaf with billbug punctures in it and the same leaf unrolled to show the characteristic row of holes and how they are produced



FIGURE 2.—Young corn plant showing leaf perforations and the “bud” twisted by the pushing of growing leaves caught in the injured tissues. Promptly cutting off such bent or twisted buds is sometimes profitable

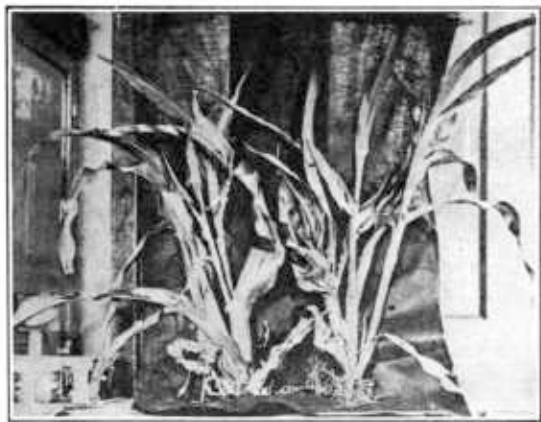


FIGURE 3.—Corn plants irreparably crippled by the maize billbug. Plants thus injured spend their remaining vitality in suckering profusely and can not produce an ear

different. The Hessian fly makes a dent in the outside wall of the stem without chewing the fiber, but the billbug grubs eat away the interior of the stem with the result that the remaining shell crushes with the weight of the top or with the wind. The billbug grubs leave these bored stems packed with debris.

Grub injury in bluegrass stems has been observed as a burrow either upward or downward from the egg cell. These burrows occasionally are as much as 15 or 18 inches in length. When the grubs become too large to continue feeding in the original stems they go down to the root stocks and fibrous rootlets to complete their growth.

appears in the form of bleached-out heads with shriveled or no kernels, some areas in margins of fields having shown from 10 to 68 per cent of the heads white on this account. Injury is more commonly indicated by breakage of straw as harvest approaches. (Fig. 5.) This breakage resembles the "lodging" of the straw where the Hessian fly has caused injury in the spring. The kind of work, however, is in the outside wall of the billbug grubs eat

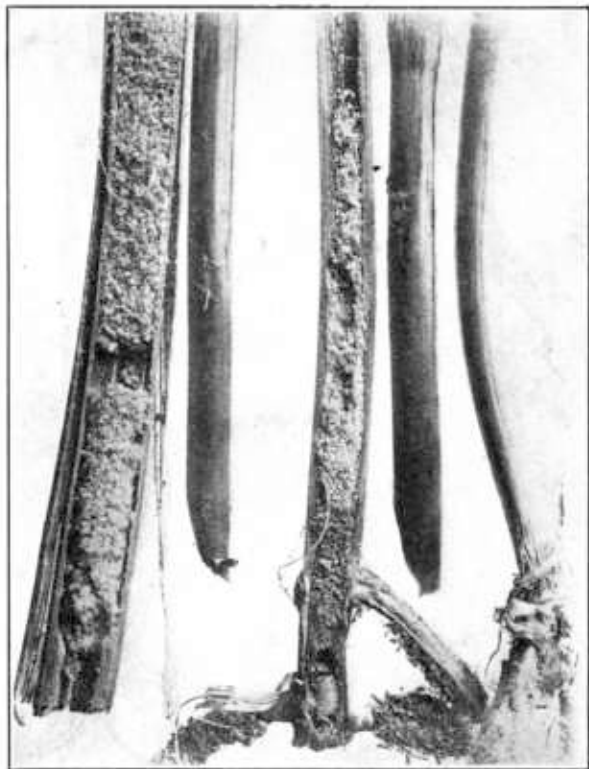


FIGURE 4.—Work of the bluegrass billbug, showing punctures in unsplit wheat straws where fibers are frayed, and frass-packed excavations in the split stems. A larva is shown in the base of the central stem

Poultry sometimes suffer severely from billbugs that they are attempting to devour alive. All of the adult billbugs are armed at the tips of the legs with strong spines with which to grip the stems on which they are feeding. When seized by a chicken or turkey they may grip the stem so tightly that their legs will be left clinging to the plant when the body is pulled free. When an uninjured billbug has been taken into the mouth of a turkey or chicken it seizes the tongue or the membrane of the mouth or throat as it would seize a stem. The more the fowl struggles to release itself, the more stubbornly the beetle clings, and the fowl sometimes dies in the struggle. The clay-colored billbug, the knife-flag billbug, and another species have been known to cause this injury to poultry, numerous cases caused by the knife-flag billbug being reported from Texas.



FIGURE 5.—Wheat falling and lodging as a result of infestation by the Phoenix billbug, which works at the bases of the stems as does the bluegrass billbug

GENERAL DESCRIPTION OF BILLBUGS

The adult billbugs are beetles ranging from one-fifth to three-fourths of an inch in length. Each possesses a long snout or bill which carries at its tip a pair of strong jaws with which the beetle chews its food and bores the cells in which its eggs are laid. The beetles have extremely hard shells, which often are more or less pitted and ribbed along the back. They range in color from clay yellow through reddish brown to jet black, but are often so covered with the soil in which they have been boring that they resemble small animated lumps of earth. When disturbed a beetle will draw in its legs, fold its bill upon its breast, and remain quiet for some time, or it may feign death with legs rigidly extended.

LIFE HISTORY OF BILLBUGS IN GENERAL

Billbugs in general require one year in which to complete their development. The adult female, which has hibernated, emerges in the spring, feeds, mates, and lays eggs. Usually she cuts a cell in a plant stem in which to deposit the egg (figs. 6, 7, 17, and 20) and egg laying covers a period of about two months during late spring and early summer. From 4 to 15 days after the eggs are laid the grubs hatch. The grub (figs. 4, 8, and 21) is a small, white, maggotlike worm with hard brown or yellow head, and looks very much like the worms often found in chestnuts. It feeds for several weeks, and

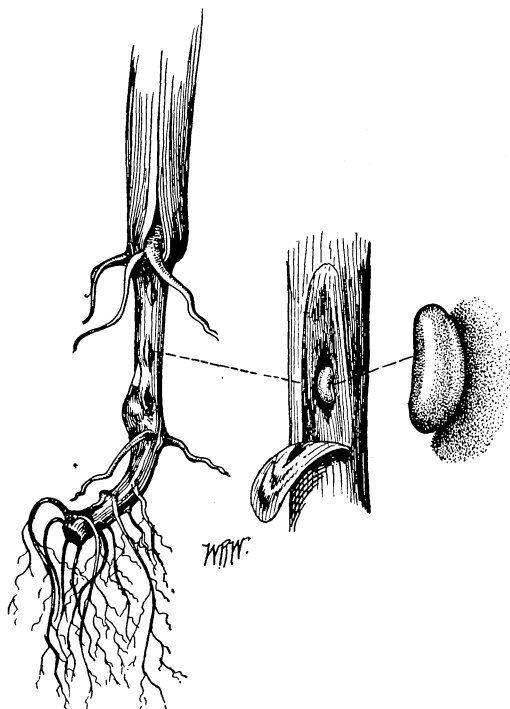


FIGURE 6.—Egg punctures of the Phoenix billbug in base of wheat plant, with egg shown in cell in opened stem, and with egg further magnified



FIGURE 7.—Egg or feeding puncture, probably of the curlew bug, in a stem of sedge

when fully fed changes to the pupa or resting stage. (Figs. 9, 17, 20, and 22.) Several days afterwards the pupa changes to an adult (figs. 10, 11, 12, 16, 19, 20, 23, and 24), which may pass the winter in the pupal cell or may emerge and lead an active life for some time before becoming dormant for the winter. In the warmer portions of the country, however, some species may pass the winter in nearly any stage of development from egg to adult.

BLUEGRASS BILLBUG

The bluegrass billbug, *Calendra parvula* (Gyllenhal) (fig. 10), is from one-fourth to five-sixteenths of an inch in length. It is a widely distributed upland species, usually infesting timothy, blue-

grass, and redtop, but often injuring wheat and occasionally oats, barley, and rye, and several wild grasses. The adult, or beetle, frequently attacks corn planted on spring-plowed old sod, dwarfing it more frequently than killing it. The effect of feeding by grubs in bluegrass is seen frequently, but the greater injury is the unseen, widespread cutting of grass root bulbs and rootlets, resulting in an annual hay and pasture loss and in premature failure of the sod.

When the grub works in timothy it may excavate the stem for about 3 inches at the base, or the corm, or both, or it may eat the root fibers and corm from beneath. The hollowed corm is often packed with the castings of the grub, called frass, and where infestation is serious the excavated ends of large numbers of the corms can be revealed by pulling up a timothy sod when the soil is dry and examining it from beneath. Pupation occurs both in the corms and in the

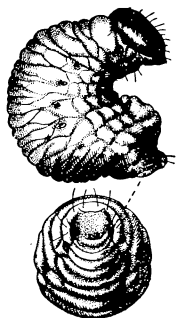


FIGURE 8.—Grub of maize billbug. Twice natural size. (Kelly)



FIGURE 9.—Pupa of the hunting billbug. Eight times natural size

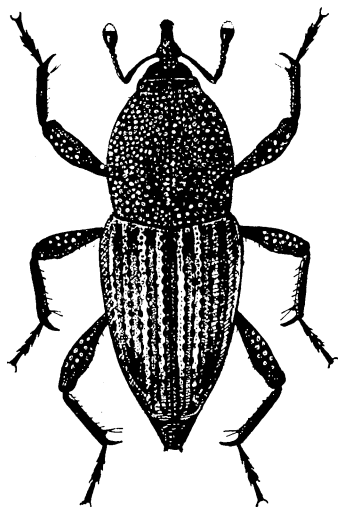


FIGURE 10.—Adult bluegrass billbug. (Chittenden, unpublished.) Eight times natural size

soil. In attacking rye the grub completely eats out the substance of the nearly solid stem up to the second joint, then goes to the roots, and sometimes destroys all the roots of a whole stool. The larval period approximates 23 days, the pupal period about 8 days in mid-summer, and the entire period from the laying of the egg to the appearance of the beetle is about 45 days. This billbug is able to remain submerged in water for days without injury.

The bluegrass billbug probably is distributed throughout the country; at least it is known from Canada to Florida and Texas and from the Atlantic coast to South Dakota. It probably ranks first in numbers and in destructiveness to farm-crop values.

TIMOTHY BILLBUG

The timothy billbug, *Calendra zeae* (Walsh) (fig. 11), has habits and life history practically the same as those of the bluegrass bill-

bug, but is larger and more robust. The two are often found in the same timothy elusters, but the bluegrass billbug prefers the higher and the timothy billbug the lower portions of the field.

The timothy billbug has been known to destroy the first and second plantings of corn and to injure the third on a spring-plowed upland 13-year-old timothy meadow, remote from either stream or swamp. It cripples much of the corn by making it sucker and fail to produce ears. This species probably ranks second in numbers and destructiveness to the

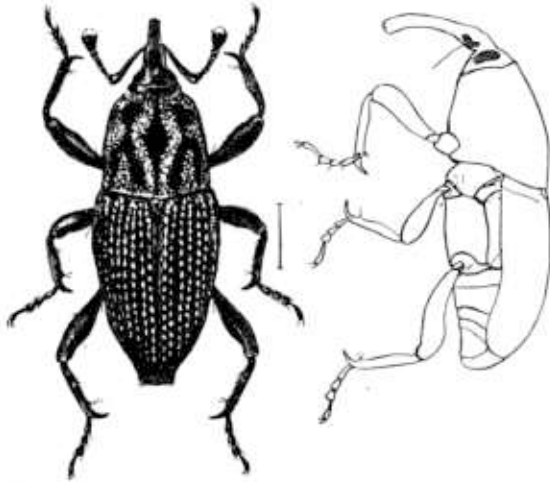


FIGURE 11.—Adult timothy billbug. Four times natural size. (Chittenden, unpublished)

bluegrass billbug, and is charged with being one of the prime causes of the early failure of meadows, the injury being caused by both grubs and adults, but more often by the former.



FIGURE 12.—Clay-colored billbug. About five times natural size. (Walton)

Although this usually appears to be an upland species, great numbers frequently have been collected in drift along overflowed streams. It occurs from Massachusetts and Michigan to Florida and Kansas and probably farther west and southwest.

The life cycle of the timothy billbug, from the laying of the egg to the issuing of the adult, consumes about 52 days. The egg stage lasts approximately 9 days, the grub stage frequently about 38 days, and the pupal stage about 7 days.

In the field eggs are laid promiscuously on leaves near the bases of their sheaths, on or in the centers of shoots, and in cells excavated in the timothy corns.

CLAY-COLORED BILLBUG

The clay-colored billbug, *Calendra aequalis* (Gyll.) (fig. 12), is a large, swamp-inhabiting species, measuring more than half an inch in length. In Illinois and Indiana it sometimes lays its eggs in cornstalks at different heights above the ground. Its natural food plant is the river rush, and the larvae burrow through the ground or the root itself to the swellings or "nuts" (fig. 13) at the ends of the roots, which should produce stalks the next year. Egg laying takes place in May, June, and July, in the latitude of Missouri, and hatching occurs in about six days. The larval stage is from about 8 to 11 weeks, the pupal stage ranges from about 7 to 18 days, and the time required from egg laying to issuance of the adult is known to range from 9 to 14 weeks.

The adults injure corn in the way described earlier in the bulletin, but instead of causing the plant to sucker they usually kill it. This billbug has also been reported from several States as climbing wheat culms and eating the grain while it is in the soft or milk stage.

In 1928 corn and wheat fields near Lewistown, Ill., suffered great losses. When the wheat was in the milk stage, damage to the parts adjacent to the corn could be seen from a mile away, the wheat appearing as if it had been seared by heat for a distance of about 20 feet all across the field. (Fig. 14.) These bleached plants had been crippled or completely killed at the base of the culms by the grubs, and the adult beetles had reached far into the field at the time of observation, eating the grains out of the heads.

Many acres of corn adjacent to the wheat were laid waste. A few plants retained sufficient life to produce suckers, but most of the plants were killed. (Fig. 15.)

This species occurs throughout the United States from the Canadian line to Arizona and eastward to the Atlantic coast. The adults

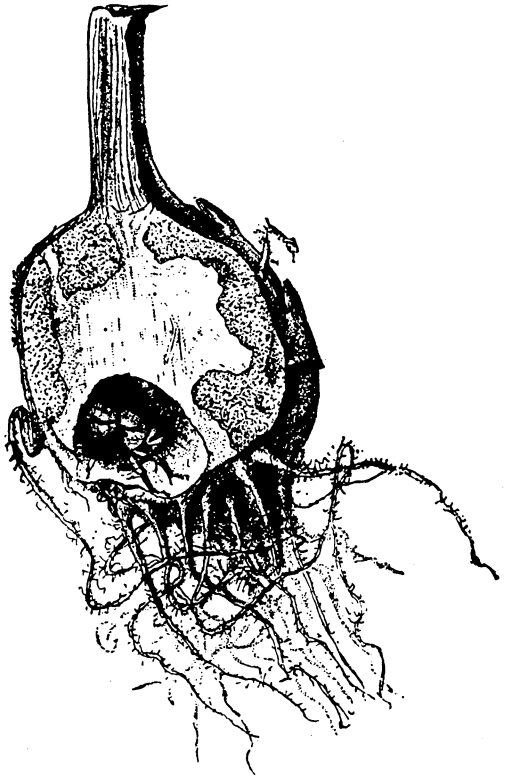


FIGURE 13.—Characteristic work of clay-colored billbug in roots of river rush. The presence of these root nuts in cornland should be a warning of the probable presence of the billbug

have been found feeding on corn, millet, foxtail, club-rush or dark-green bulrush, river bulrush, bristly nut grass or straw-colored Cyperus, and common reed grass, and the grubs feeding and developing in rushes, sedges, and reeds.



FIGURE 14.—A wheat field near Lewistown, Ill., showing uninjured wheat at the left and a strip at the right badly damaged by the clay-colored billbug. (Photo by J. E. Watt)

MAIZE BILLBUG

The maize billbug, *Calendra maidis* (Chittnn.) (fig. 16), is four-tenths to six-tenths of an inch long. It is broad and proportionately



FIGURE 15.—Work of clay-colored billbug in corn, Lewis-town, Ill., June 19, 1928. (Photo by J. E. Watt)

thicker through the body than any of the other billbugs; it is dark reddish brown or black when not covered or colored with mud, and the wing covers have several raised, rounded, smooth lines running about two-thirds of the way back, these often showing through the mud. Its double injury to corn, as adult and as grub, was observed as early as 1855. Fortunately

there are only one or two other species injurious in both adult and larval stages.

The adult injures young corn plants by piercing the stem and eating out a quantity of tissue. This causes the plant to sucker (fig. 3),

thus providing young, succulent corn for the billbug for some time after uninjured corn has become too hard for it. These crippled plants are nonproductive. Where very young corn is attacked one adult may travel down the row and injure many plants, which will wilt down within a few minutes or a few hours.

The adult billbug also injures the corn by making an excavation for its eggs (fig. 17, *b*) in the stalk at or below the surface of the soil. These eggs are creamy white and somewhat kidney-shaped. They hatch in from 7 to 12 days. The grub (fig. 8) feeds within the cornstalk and in the main root, and after 40 or 50 days makes its pupal cell in the upper part of the main root and pupates. (Fig. 17, *a*.)

The grub injury to corn dwarfs the plant (fig. 18) and sometimes kills it. The pupal period lasts 10 or 12 days.

The food plants of the maize billbug are corn and gama grass.

The maize billbug, in Kansas, lays its eggs in June, the grubs work from early June to September, and pupae are found during late August and early September, apparently always in the tunnel made by the grub. The adults that develop early leave the pupal cells and disappear for hibernation elsewhere, but those maturing later hibernate in the grub excavations in the corn and may be destroyed by carefully pulling up and burning the stubble and roots. If the roots are plowed out and harrowed to remove the dirt, the hibernating beetles will die during the winter, but if the roots are left in the ground the beetles will survive, become active about corn-planting time, and seek out any nearby cornfield. One farmer has found it profitable to attach to his cultivators cans containing water and a layer of kerosene into which he dropped every billbug seen during the migrating period. Several thousand were collected during a single season.

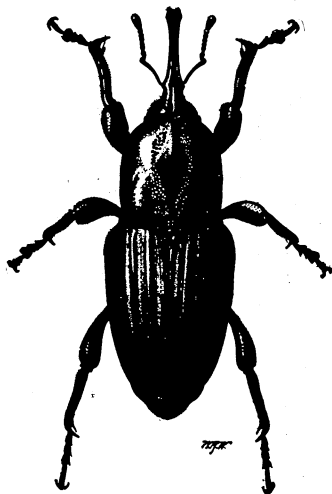


FIGURE 16.—The adult maize billbug. Four times natural size. (Kelly)

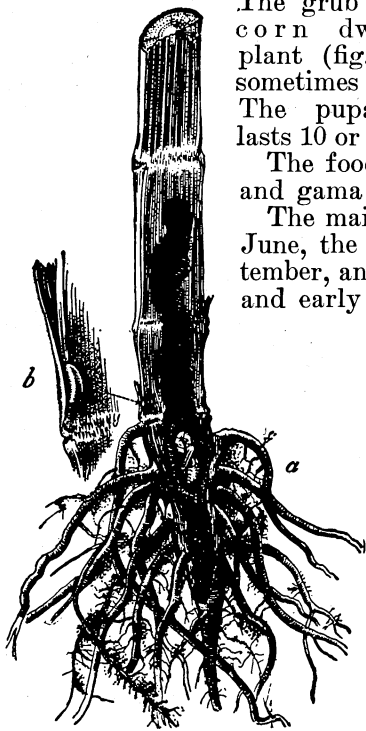


FIGURE 17.—Work of maize billbug in corn stubble: *a*, The grub excavation and the pupa in the pupal cell near the top of the main root; *b*, egg, at or below surface of ground (enlarged). (Kelly)



FIGURE 18.—Corn plants showing effect of feeding of maize billbug in the field. Plant at left not injured, the two at right attacked by grubs. (Kelly)

In Kansas, South Carolina, and Alabama the species is very destructive, both the adults and grubs injuring the corn. This billbug is found also in Texas.

CURLEW BUG

The curlew bug, *Calendra callosa* (Oliv.) (fig. 19), is a species frequenting every city gutter, every roadside ditch in highland or lowland, and every field where chufa or yellow nut grass grows. Nut grass seeks the low places for moisture, but is not restricted to lowland in the full sense. This insect averages about three-eighths of an inch in length but may reach five-eighths of an inch. The beetle is usually mud colored, but as the natural coating, brown with gold in favorable lights, wears off, the more prominent bumps become polished and black. A large dent in each wing cover near the base and a prominent callous hump near the extremity of each wing cover will help in identifying this billbug.

Complete destruction of entire fields of corn by the curlew bug is frequent in the South Atlantic States, where the greater portion of the damage is done by the grubs feeding in the base of the cornstalk and in the taproot. Similar injury by these grubs is recorded from New Mexico, Oklahoma, and Kansas. Next to corn, rice and peanuts are the crops most injured. Rice crops occasionally are abandoned on account of this pest.

The eggs are laid in corn (fig. 20, *b*) in the Carolinas and possibly in Georgia, and throughout the country generally in chufa, bristly nut grass or straw-colored *Cyperus*, and another nut grass, and probably in all species of plants in which grubs have been found. As many as 447 eggs have been recorded as having been deposited by one female. The beetles lay their eggs in the stalks of young corn, either below the surface of the soil or within an inch above, and after the corn is older they deposit their eggs in the nut grasses.

During the egg-laying season the adults usually travel over the ground on foot and rest either on the plants, head down, or under stones, trash, or clods of earth, or bask in the sun. They may also travel by flight.

The eggs hatch in from 4 to 12 days. The insects remain then in the grub stage for periods of from less than 40 days in midsummer to over 70 days in the fall, lower temperatures and lack of food tending to extend the period. The grubs (fig. 21, *a* and *b*) have been found in corn, a number of sedges, certain grasses, rice, and peanuts.

The tunnel made by the grub in a corn root is well shown in Figure 20, *c*.

It has been estimated that in certain years this billbug has done more damage to corn in North Carolina than all other corn insects

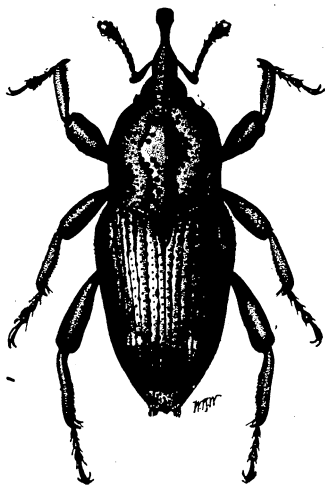


FIGURE 19.—The adult curlew bug. Four times natural size. (Webster)

together. In Missouri and Indiana this species may be the most conspicuous in the cornfields, though probably ranking third in the number of individuals and in destructiveness to crops.

Pupation requires from about six to eight days. The pupa (fig. 22) is white to cream color and ranges in length from seven-sixteenth to five-eighths of an inch. Pupae may be found from about six

weeks after the first eggs are found until late fall. Early maturing beetles leave their pupal cells within a few days, and a few of these early individuals may lay a part of their eggs the same season. Where pupation occurs in corn the pupa (fig. 20, *c*) is lower down than that of the maize billbug (fig. 17, *a*), making the hand pulling of roots useless because the tip, containing the insect, often breaks off and remains in the ground.

The adults live from one summer to the following summer, and their presence is easily ascertained in midsummer in the Wabash and Mississippi Valleys, and probably throughout their territory, by the dead centers (either leaves or flower stalks) of nut-grass plants, even when this troublesome billbug is not, at the time, destructive to corn.



FIGURE 20.—The curlew bug: *a*, Corn plant attacked by adult insect, showing crippled stalk, perforated leaves, and leaf broken at perforations; *b*, egg as placed in young corn plant (enlarged); *c*, pupa in grub excavation, and adult in excavation near tip of main root, as for hibernation. (Webster)

Its range is from Maine to Arizona and from Wisconsin to Florida, and probably coincides with that of its favorite nut grass.

TULE BILLBUG

The tule billbug, *Calendra discolor* (Mann.), is the largest of all the injurious species, being about three-fourths of an inch in length, and is dark brown with light markings on the sides and

undersurface. Another species (*C. picta* LeConte) differs only in having additional white markings on its back.

This species is not aggressive, but when the farmer incautiously encroaches upon its domain it attacks cultivated crops, such as barley, oats, and wheat.

It occurs in the tule marshes of California from San Diego to north of San Francisco. The grubs work in the tule, and the adults begin to work early in the spring, causing losses to growing grain planted adjacent to recently reclaimed tule swamps or on them.

Although recognized since 1857, its injuries to crops thus far have been limited to the immediate vicinity of the swamps, and greatest on newly reclaimed land, but as it is not known to breed in cultivated crops or to require more than one season for development, clean cultivation for one year eliminates it from such land. When grain

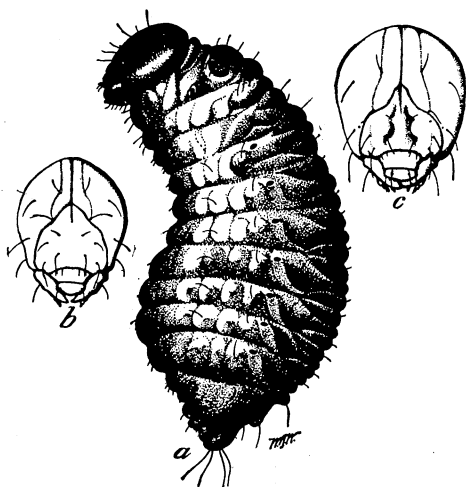


FIGURE 21.—*a*, Grub of the curlew bug; *b*, head of same; *c*, head of maize billbug. *a*, Four times natural size; *b* and *c*, more enlarged. (Webster)

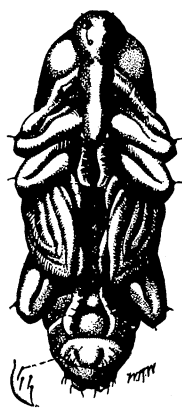


FIGURE 22.—Pupa of the curlew bug. Four times natural size. (Webster)

is planted within its range it cuts the heads of the growing stalks at the boot, thus killing the top, and also after the grain forms the adults feed on the soft grain in the head.

CATTAIL BILLBUG

The adult cattail billbug, *Calendra pertinax* (Oliv.) (fig. 23), measures from seven-sixteenths to five-eighths of an inch in length, and the depressions on its back are coated with pale clay-yellow hairlike velvet.

This billbug has long been considered among the most important of the billbugs attacking corn. It was recognized as early as 1807, and by 1873 it was known from Canada to Louisiana and from the Atlantic to the Pacific. It is a lowland species usually working on cattail flags, but becoming of great economic importance wherever infested waste land is reclaimed for corn growing. The beetle is

extremely destructive to growing corn, burrowing into the soil and attacking the stalk from below the surface of the ground, causing the plant to dwarf and fail to ear, rather than to die outright. The adults work from April to August and rest hidden in the soil. Egg laying begins by the latter part of June, and the eggs usually are placed about cattail flags and bur reed. The grubs are not found in corn. They are believed to winter over to some extent in the pupal stage, although generally changing to adults before November. It is believed that most of those which do not transform to adults in late summer or early fall perish without reaching maturity.

DESTRUCTIVE BILLBUG

The destructive billbug, *Calendra destructor* Chittnn. (fig. 24), is from one-fourth to three-eighths of an inch in length, is black, thickly covered with a dull clay-colored or brownish coating, and is rather rough in appearance.



FIGURE 23.—The adult cattail billbug. Five times natural size

This appropriately named billbug is one of the more common species occurring in cornfields throughout its range, which extends from New Jersey to Kansas and Texas. It is especially destructive in Missouri. Observations indicate that it is or may become destructive in the larval stage to timothy and wheat. A single female is able to lay at least 30 eggs. Adults are known to live nearly a year. The destructive billbug frequently is found in the same fields as the curlew

bug and associated with it at the same feeding plants and the same shelters, and ranks next in abundance to it.

HUNTING BILLBUG

The hunting billbug, *Calendra venatus* (Say), is from one-fourth to two-fifths of an inch in length and is black, densely pitted on the back between the head and wing covers and on the ridges of the wing covers. It is destructive to timothy and corn. The adult injures wheat (fig. 25) and corn in the usual billbug fashion. It is active from April to August or later, laying eggs until August 30, in Missouri. The grub develops in wheat and timothy, but its habits are not well known. The pupa is shown in Figure 9.

The adults are usually found in cornfields infested with bristly nut grass and in plants of Bermuda grass, and are frequently found

in drift from high water. The species ranges from Maine to Florida and from Wisconsin to Texas and seems to prefer lowland.

PHOENIX BILLBUG

The Phoenix billbug, *Calendra phoeniciensis* (Chittnn.), measures about three-tenths of an inch in length and is variable in color, ranging from light tan, when first mature, to a deep brown or black with a velvety coating of gray to pale reddish. This insect has been known since 1904. It is very destructive in the Salt River Valley of Arizona in the vicinity of Phoenix (hence its name) and is also found in California.

This billbug begins its work early in the spring, often causing serious injury which is not noticed until it is too late to save the crop, although prompt irrigation may save part by stimulating growth. The beetles congregate, as many as 12 to a single plant, on tender stools of wheat or barley planted on or near infested sod of old Bermuda grass. They puncture the stems and eat out the soft interior tissue. This work continues from early spring, or even during warm spells in winter, until the middle of June. Part of the damage by the beetles

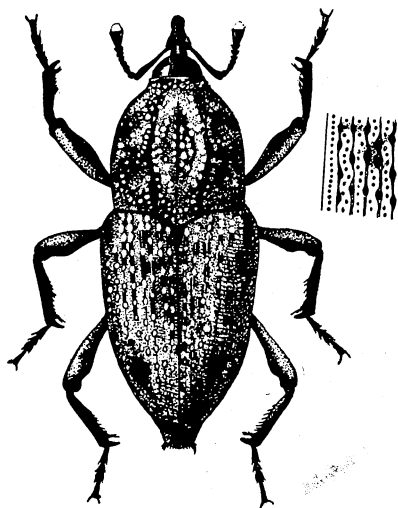


FIGURE 24.—Adult of the destructive billbug. Seven times natural size. A portion of the wing cover much more enlarged is shown at the side. (Chittenden, unpublished)



FIGURE 25.—Work of the hunting billbug grub in the base of wheat stems, with frass left in the excavations

is done when they excavate places for egg laying in the stem, though when the plants are quite young this may be in the tender tips. When the egg excavation or puncture is in the tip of the young plant the plant dies. Many stems die early from the punctures; many which remain for harvest produce small heads, and a substantial portion of the stalks fall just before harvest time on account of the damage done to the stems. (Fig. 5.) The economic importance of the pest is measured by crop losses in wheat or barley, which may be nearly 100 per cent. Almost without exception only one egg is

laid in a stem. The eggs laid in March and April hatch in from 8 to 13 days, and those laid in May in from 6 to 8 days. Pupation occurs from early June to fall in compact earthen cells in the soil and, though rarely, in larval excavations in sugarcane. Development, from the hatching of the egg to the appearance of the adult, requires about two months.

TERRELL-GRASS BILLBUG

The Terrell-grass billbug, *Calendra minima* (Hart), is from one-fifth to one-fourth of an inch long. It is dull black, covered with a rich brown pile, which when soiled appears as a pale clay-colored coat. On the forward part of its back are numerous wide shallow pits.

This little fellow is as sly as the timothy billbug in tapping the farmer's till, and uses the same underground system of theft. It occurs from New York to Texas and from Illinois to Florida. Its known food plants are rice, timothy, quack grass, wild rye or Terrell grass, reedtop, wheat, and meadow grass. It has been found destructive to timothy in Indiana, Ohio, Kentucky, and especially Michigan, where serious damage to sod is common. In the vicinity of Pittsburgh, Pa., this is the most abundant billbug. The amount of damage wrought by it can not be easily determined, for it is very inconspicuous as a beetle and works beneath the surface of the sod. The grub of the little billbug hollows out the corm of timothy plants.

The egg period is known to be less than 8 days, the grub period between 27 and 33 days, and the pupal period 7 days or more. The entire development is frequently accomplished in less than 60 days, though occasionally requiring about 70 days.

OBLITE BILLBUG

The oblite billbug, *Calendra oblita* (LeConte), is about one-fourth to five-sixteenths of an inch in length, very similar in appearance to the bluegrass billbug, except particularly that the beak of the bluegrass billbug is long and slender whereas that of the oblite billbug is perhaps only three-fourths as long and much heavier. This billbug has been reared from timothy in Illinois and Michigan. It has proven extremely destructive to fields subject to occasional overflow in the neighborhood of Vicksburg, Miss. The preferred host plant has not been ascertained. The insect has demonstrated its economic status, however, by destroying the first planting and almost completely destroying the second planting of corn on several acres of good cornland, and it has demonstrated its ability to propagate in timothy.

The females of this billbug begin to lay their eggs rather late in the summer, and in cage experiments the larvae seemed extremely slow in developing, spending five months or more in the larval stage under what were presumed to be natural conditions. Its life cycle will be comparable in Michigan and Illinois to that of the bluegrass billbug, whereas in the Gulf Coast States the eggs will be laid in late summer or fall, and the winter may be successfully passed in the larval, pupal, or adult stage.

These billbugs are found from Wisconsin to New Mexico and Arizona and in Maryland.

OTHER SPECIES OF BILLBUGS

Several other species of billbugs have been recorded as attacking farm crops. Among these is the uneven billbug, *Calendra inaequalis* (Say), about one-fourth inch long, with back unevenly surfaced and body relatively broad-oval. This insect has proven injurious to turf plats at the Florida Agricultural Experiment Station. The uneven billbug occurs chiefly in the Atlantic Coast States from New York to Alabama, but has been recorded from Minnesota.

The knife-flag billbug, *Calendra ludoviciana* (Chittnn.), is about five-eighths of an inch long, much like the cattail billbug but with all markings of wing covers regularly longitudinal. Its natural food plant is the knife flag (*Zizaniopsis miliacea*). This billbug has been identified as particularly injurious to turkeys which have ranged within the area infested by it. It occurs in the Gulf Coast States and as far north as southeastern Missouri.

The lake-bank sedge billbug, *Calendra costicollis* var. *callosipennis* (Chittnn.), is about three-eighths to one-half inch in length and is heavily coated with brownish-yellow velvety hairs with three glossy black lines on the back near the head and a glossy black line and two longitudinal spots on each wing cover. This billbug is known to occur in the Mississippi Valley and in Kansas and Alabama.

The beaked-rush billbug, *Calendra cariosa* (Oliv.), is three-eighths to one-half inch long, the front two-fifths of the back bearing two black, polished, raised lines about a more or less diamond-shaped, elevated, polished space. Each wing cover has two elevated, polished lines at the base, and they are generally marked with broad-tipped, circular depressions, heavily coated with hairs. This billbug is generally distributed from Massachusetts to Texas and from Nebraska to Florida.

The tall marsh grass billbug, *Calendra scoparia* (Horn), is about one-quarter to one-half inch long and much like the maize billbug, but the male is easily recognized by a great projection on the inner back surface of the hind leg with an unusually long brush of hairs. This billbug occurs over a large part of the country including Wisconsin, Nebraska, Alabama, and Maryland.

These last three billbugs have proven destructive to corn in Missouri. The lake-bank sedge billbug and the tall marsh grass billbug were frequently found together in the same cornfield and apparently had come from the same infested lake-bank sedge.

The cut-grass billbug, *Calendra melanocephala* (Fab.), is about five-sixteenths to seven-sixteenths of an inch long, velvety all over except for a small polished spot, with or without a polished line before and behind, on the back near the head. Occasionally there is a small polished area near the base and another near the point of each wing cover. This billbug seems closely restricted to spots where cut-grass grows, but it has been taken with other billbugs in timothy and has been taken occasionally with billbugs collected on corn. It is widely distributed from Ontario, Minnesota, and New Hampshire to Virginia and Oklahoma.

NATURAL ENEMIES OF BILLBUGS

Although the grower can not wait for nature unassisted to control the insect pests which are destroying his crops, nevertheless the good work of the natural checks is by no means to be ignored. These checks are insect, worm, and fungous parasites, toads, birds, and doubtless other insect-eating animals.

INSECT PARASITES

Wasplike insect parasites in the grub stage, feeding on the outside of billbug grubs, have been found at many places and doubtless render considerable aid at times.

A very showy parasite, *Zavipio belfragei* Cress., with black wings and red body, has been reared from grubs of the curlew bug from Athens, La Fayette, and Muncie, Ind. A dipterous parasite, *Myiophasia metallica* Tns., a member of the tachinid family of 2-winged flies, is a useful parasite in the control of the bluegrass billbug and the lake-bank sedge billbug, and no doubt helps in the control of other species also.

TOADS

The American toad is a very efficient consumer of insects, adapting itself to farm, garden, or urban hunting grounds. In Arizona 4 out of 10 toads killed and dissected between April 4 and July 22, 1913, contained 13 Phoenix billbugs.

REPTILES

A report on the examination of a number of alligator stomachs reveals the fact that beetles represented 20 per cent of the stomach contents, and one-twentieth of this insect content was corn billbugs. Among these were the curlew bug, the clay-colored billbug, the hunting billbug, and the cattail billbug.

BIRDS

Many kinds of birds have been found feeding on billbugs. Flocks of them gather where the pests are especially numerous, and birds should be fostered and protected regularly to increase the value of their services. Eliminating vagrant cats and restricting those valued as house pets will save the lives of many birds, as will also the provision of food and shelter for birds in winter.

The following birds, besides many others, are known to feed on various species of billbugs: Crow blackbird, red-headed woodpecker, wood pewee, bobwhite, kingbird, English sparrow, cardinal, phoebe, nighthawk, song sparrow, western vesper sparrow, red-wing, thick-billed red-wing, meadow lark, crow, catbird, brown thrasher, Wilson phalarope, avocet, black-necked stilt, pectoral sandpiper, killdeer, upland plover, Franklin gull, horned lark, and flicker.

MEANS OF CONTROL

Serious billbug injury to cultivated crops may easily be prevented by the following simple, beneficial cultural practices: Clean cultivation, fall plowing, planting of crops immune to billbug injury, proper

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Washington, D. C.

rotation of crops, improved drainage of damp lands, and community adoption of control measures.

Clean cultivation in this case means eliminating nut grasses and other sedges, and flags, cattails, and other rushes, together with all moisture-loving wild grasses, from ground intended for corn. Where possible, the first season after breaking, some crop known to be immune to billbugs, such as cotton, cowpeas, soybeans, flax, or potatoes, should be planted.

Damp lands intended for corn growing should be plowed in late summer and proper drainage should be provided, where at all possible, to prevent winter flooding.

A suitable system of crop rotation is one in which corn will not be grown on the same land more than two years in succession. In the South cotton, soybeans, or cowpeas may be substituted for corn, if clean cultivation is practiced in order to eliminate sedges, and this will greatly aid in controlling billbugs. In the North the growing of crops such as soybeans, flax, or such vegetable crops as potatoes will serve the same purpose. The first year after breaking corn should not be planted on ground on which chufa has grown. Chufa, grown in certain portions of the South as forage for hogs, serves as a breeding ground for several species of billbugs, and serious injury may be expected if corn is planted on such land the first year following this crop.

Thorough drainage of infested land is always of great benefit. Tile drainage is preferable, but where this is impracticable, open ditching is beneficial. The addition of lime to damp, sour land usually is necessary, and tends to render such land less suitable for the growth of sedges, rushes, and other moisture-loving plants, which are the natural food of billbugs.

CONTROLLING CLAY-COLORED, BLUEGRASS, AND TIMOTHY BILLBUGS

The clay-colored, bluegrass, and timothy billbugs are known to be able to complete their development in bulbs or tubers thrown out by the plow and exposed to the sun for more than a month in the summer. It is therefore not to be expected that plowing will kill all the insects in these bulbs.

However, the adult beetles, on emerging, will need food, and destroying the plants on which they might feed until time to hibernate will force them to migrate from the plowed lands. After they have gone into hibernation they will survive without food, so it is essential that fall plowing be done before the weather becomes so cool as to drive them to their winter quarters. If this is done they will migrate, feed a while longer, and then hibernate in their new locality.

CONTROLLING THE PHOENIX BILLBUG

As the Phoenix billbug can not complete its life cycle in wheat or barley, but requires Bermuda grass or other large grasses in which to finish its growth, eliminating these grasses and sedges from grain fields reduces injury by this beetle.

CONTROLLING THE CURLEW BUG AND THE MAIZE BILLBUG

The curlew bug and the maize billbug are easily eliminated from cornfields by practicing a suitable rotation of crops, alternating corn

with cotton or some other cultivated crop, such as potatoes, upon which they can not live, and practicing clean cultivation. All chufa or other sedges must be destroyed if complete elimination of curlew-bug injury is to be secured.

The following method of treating corn stubble has been found very effective in the control of the maize billbug: Plow out the stubble after the cold weather has ended all activity of the billbugs, and drag the plowed-out roots with a spring-tooth harrow or other device that will loosen the soil from the taproots. This will expose the insects to the fluctuating temperatures of winter. Follow this with hand picking.

This method should be equally effective in the control of the curlew bug where it makes a practice of wintering in the taproots of the corn.

OTHER REMEDIAL MEASURES

Where the preventive measures mentioned have not been practiced, it is sometimes possible to prevent the maximum injury from billbugs by using certain palliative methods, such as planting corn at the earliest safe date for the curlew bug, or planting wheat or barley early in the fall in the case of the Phoenix billbug.

In corn which has been injured by billbugs, causing the "buds," or growing points, to break over or twist (fig. 2), the buds may be immediately clipped with scissors or shears just below the break. This treatment frequently restores the plant to productiveness. The application of suitable fertilizers also enables plants to overcome injuries which have already occurred from billbugs. Before applying such fertilizers, however, the grower will do well to consult the county agricultural agent, the State agricultural college, or the Bureau of Chemistry and Soils of the United States Department of Agriculture as to the character of fertilizer to be applied, which should be that best suited to meet the requirements of the particular soil involved.

COOPERATION

The cultural practices described have proved effective locally, but at least one thing more is necessary in order to render them fully effective. This is community action. Community adoption of a 2-year maximum period for timothy; early fall plowing, either of cultivated sod or of plain swamp sod, or the planting of flax or cotton for the first crop will so reduce billbug injury as to render it of little account.

The best use of the methods that have proved their value should be made, and every experience of billbug injuries should aid the further search for better methods, better dates for operations, and means for securing more profitable first crops.